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ABSTRACT

This study investigated the effects of background television on cognitive performance as it applies to reading comprehension and memory using G. B. Armstrong and B. S. Greenberg's (1990) model. Subjects, 95 undergraduates from lower-level communication courses, completed a cued-recall test of the content of an expository prose passage read under quiet conditions or concurrently with the presence of one of two types of television content (prime-time drama versus commercials). Effects on immediate versus delayed recall were examined. Results indicated: (1) significant deleterious effects of background television were found, controlling for prior abilities and motivation; (2) deleterious effects were stronger and more consistent when testing occurred immediately after reading, rather than after a 5-minute filled delay; and (3) background commercials resulted in more consistently negative effects than did television drama. (Three tables of data and 22 footnotes are included; 52 references are attached.) (RS)

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Background Television and Reading Performance

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ABSTRACT

Background Television and Reading Performance

An experiment was conducted testing Armstrong and Greenberg's (1990) model of the effect of background television on cognitive performance, as it applies to reading comprehension and memory. Subjects completed a cued-recall test of the content of an expository prose passage read under quiet conditions or concurrently with the presence of one of two types of television content (prime-time drama versus commercials). Effects on immediate versus delayed recall were examined. Overall, significant deleterious effects of background television were found, controlling for prior abilities and motivation. Deleterious effects were more strong and consistent when testing occurred immediately after reading, rather than after a five-minute filled delay. Background commercials resulted in more consistently negative effects than did TV drama.

Background Television and Reading Performance[1]

The question of whether television viewing has a deleterious effect on intellectual growth or student achievement has generated a substantial amount of research to date, although disagreement persists on the strength of findings and the conclusions they warrant (cf., Anderson & Collins, 1988; Morgan & Gross, 1982; Potter, 1987). A large number of correlational studies have shown negative relationships between amount of viewing and student achievement, at least at high viewing levels, but the strength and reliability of these relationships appear to depend upon a number of contingent factors (Fetler, 1984; Ward, Mead, & Searls, 1983). While overall, the TV/achievement relationship appears curvilinear (with highest achievement in some middle range of viewing), substantial differences are often found when subpopulations differing in age, ability, socioeconomic background, and the like are separately assessed (Morgan & Gross, 1982; Williams, Haertel, Haertel, & Walberg, 1982). Such analyses suggest an apparently more benign effect of moderate viewing levels on younger students, students from lower socioeconomic backgrounds, and students with lower ability, possibly as a positive result of direct content learning and enrichment (Hornik, 1981; Noble, 1983; cf., Potter 1987).

The strongest academic controversy has arisen over explanations for the negative TV/achievement correlation found at higher viewing levels. Commonly advanced causal explanations have included the development of a cognitive or behavioral style inappropriate to the school environment ("intolerance for the pace of schooling") and the displacement of homework, reading, or other activities conducive to intellectual growth (Hornik, 1981). The empirical relationships actually obtained in the majority of

correlational studies are most consistent with the predictions of the second explanation (Potter, 1987). However, neither hypothesis has done particularly well under more direct test (Anderson, Levin, & Lorch, 1977; Morgan, 1980).

Recently, Armstrong and Greenberg (1990) proposed that negative empirical relationships between viewing and various achievement measures among older, higher SES, and more able students may result in part from the frequent combination (particularly among heavier viewers) of television watching with other intellectual activities (Anderson, Lorch, Field, Collins, & Nathan, 1986; Lyle & Hoffman, 1972; Patton, Stinard, & Routh, 1983). Armstrong and Greenberg assessed four processes through which television as a secondary activity could potentially reduce the quality of cognitive processing applied to concurrent intellectual tasks (such as reading, studying, and doing homework), drawing on Kahneman's (1973) "capacity model" of attention.

Kahneman argued that an individual has, at any given moment, a limited amount of general attentional capacity that can be applied to different information processing tasks. "Capacity interference" occurs when two concurrent activities -- such as television viewing and reading -- compete for this limited pool of central processing resources, and the combined demands of the concurrent tasks exceed the available processing capacity (cf., Norman & Bobrow, 1975).

Information processing activities may also compete for more specific processing resources (such as the "articulatory loop" in working memory), leading to "structural interference" (Allport, 1980). Structural interference occurs when similar mental operations are required for two

concurrent tasks; thus, activities with similar information processing demands are more likely to interfere with one another (Brooks, 1968; Wickens, 1980). Armstrong and Greenberg specifically addressed the possibility that the verbal content of television could produce structural interference with concurrent linguistic processing.

Armstrong & Greenberg also suggested that involuntary orienting responses (OR) elicited by background TV might interfere with concurrent cognitive processing by interrupting concentration, disrupting short-term memory, and creating physiological changes advantageous to perceptual processing at the expense of internally-directed thinking (Lang & Thorson, 1989; Ohman, 1979; Sokolov, 1963). The influence of television on physiological arousal implied a fourth mechanism through which information-processing efficiency could conceivably be affected; indeed, performance effects of very high background noise levels have often been explained in terms of the effects of arousal (Hancock, 1984; Hockey, 1969).[2]

Armstrong and Greenberg conducted an experiment whose results showed background television impairing performance on three types of "synthetic" information-processing tasks, each requiring strategic use of multiple cognitive operations (Hunt, 1980). Four tasks involving collections of simpler, self-contained, problems were unaffected.[3] Overall results were interpreted as most consistent with the hypothesis that background television affected performance through capacity interference.

One of Armstrong and Greenberg's more surprising findings was that background television had only a relatively weak effect on reading comprehension, which in fact only achieved significance when subjects were instructed to appropriate a minimum amount of attention to the television

content. The weakness of this effect was surprising from a theoretical standpoint, in that extant models of text comprehension in reading (e.g., Kintsch & van Dijk, 1978) explicitly recognize the importance -- to both text comprehension and memory -- of the amount of available central processing capacity. Moreover, measures of reading comprehension have been shown empirically to be susceptible to other environmental distractors, including (but not limited to) background speech, that are quite similar to components of background television (Baker & Madell, 1965; Etaugh & Michaels, 1975). There is also evidence that distractors of this sort can interfere with some specific information-processing operations involved in on-line reading comprehension, such as recall of information from semantic memory (e.g. Smith, 1985).

The capacity interference concept implies that two tasks will interfere with one another only when the total resources required by the combined tasks exceeds the currently available processing capacity (Norman & Bobrow, 1975). Thus, if a particular reading task was easy enough to leave sufficient spare capacity, that spare capacity could be used to overcome an unwanted distractor without measurable effect on reading performance. On the other hand, an increase in either the strength of the distractor (due to its intrinsic qualities or to the individual's task set) or the difficulty of the reading task could result in a substantial deterioration in performance.[4]

In this light, the reading comprehension measure used by Armstrong and Greenberg -- a shortened version of the Nelson-Denny Reading Test -- had at least three characteristics that especially limited its usefulness for testing TV distraction effects: (1) it was originally geared to high

school juniors and seniors, rather than the college freshmen and sophomores who were Armstrong and Greenberg's subjects; (2) it used a multiple-choice format; and (3) the reading passage remained available for review during testing. The first of these properties provides reason to question whether the test was sufficiently challenging (to these subjects) to be very sensitive to capacity interference effects; the second and third illuminate the fact that the Nelson-Denny test explicitly did not measure reading memory: The ability to store and recall information from written text. Memory for written textual material is, however, particularly important from a practical standpoint (as well as to Armstrong and Greenberg's argument concerning the broader impact of TV distraction on school performance). Reading is a main vehicle through which other school-related knowledge and skills are acquired; thus, in study contexts, the student is usually reading not just for immediate comprehension, but for the sake of later memory of text information.[5]

The cognitive operations involved in storing semantic information in memory in a form enabling later intentional retrieval generally involve additional (and often substantial) amounts of conscious (non-automatic) processing beyond that required for immediate, micro-level, comprehension (Kintsch & van Dijk, 1978).[6] For example, information can be fixed in memory by actively relating it to other ideas and concepts already in permanent memory, or to particular goals and plans (Cappella & Folger, 1980; Craik & Lockhart, 1972), but such deeper levels of processing can make substantial demands on processing resources (Craik & Tulving, 1975; Simon, 1979). Imposing hierarchical structure or organization on text material also aids memory (Bower, Clark, Lesgold, & Winzenz, 1969), but

this operation too will usually require allocation of additional attentional capacity at encoding. This implies that recall memory of written material should be more susceptible than recognition memory or immediate comprehension to capacity interference effects of background TV.

The present study was intended to test implications of the capacity model for the effects of background television on recall memory of difficult written textual material.[7] It was hypothesized that capacity interference from television would impair recall performance if reading materials were sufficiently difficult, even when subjects were motivated to ignore the television and concentrate on reading. A secondary purpose of the study was to allow an initial assessment of whether TV-induced recall deficits resulted solely from differences in initial comprehension and immediately available memory, or whether additional performance decrements may result from differential memory decay (consolidation failure) or interference at the point of retrieval or reconstruction. The strategy used for exploring this question involved comparison of immediate versus delayed recall of text information in television and quiet conditions. We predicted an additional performance decrement when testing was delayed, resulting both from less efficient initial storage (leading to more rapid memory decay) and from direct capacity interference during the reconstruction/retrieval process.

In the Armstrong and Greenberg (1990) study, an attempt was made to assess the degree to which content characteristics affected the potency of background television as a distractor. Of particular interest was the relationship between performance and two content variables: verbal dialog and physical action (involving frequent occurrence of "perceptually

salient" formal features such as rapid cuts, sound effects, visual change and action, etc.; cf. Rice, Huston, & Wright, 1982). Except for an interaction effect (with task set) found for one of the tests, program type (high talk/low action versus high action/low talk) failed to distinguish the performance of subjects in treatment conditions. However, the content manipulation used may have been too weak, in that the high action/low talk programs still contained substantial dialog, and highly perceptually salient features occurred only intermittently.

For their content manipulations, Armstrong & Greenberg used prime-time programs from which commercials had been removed. However, the TV commercial is a genre that appears to involve a particularly high frequency of the sort of perceptually-salient features that many have argued to be involuntarily attention-grabbing (Berlyne, 1960, 1970; Hochberg & Brooks, 1978).[8] As a result, advertising may actually be the most difficult type of content to ignore completely. Certainly, the producers of television commercials are aware that their audience is not intrinsically motivated to attend; therefore, they must construct their ads specifically to be attention-grabbing if they are to be successful. Commercials have been shown experimentally to elicit orienting responses from viewers (Lang, 1988).[9] If "perceptually salient" content of this type is indeed harder to tune out voluntarily, commercials should show relatively greater potential for causing capacity interference (among those attempting to ignore the television), and should therefore lead to stronger distraction effects on concurrent tasks.

In summary, we had the following expectations. First, we predicted that exposure to background TV would negatively affect recall memory of

information from a written expository text. Second, we predicted that background advertising content would have stronger negative effects on reading comprehension and memory than would TV drama. Third, we expected stronger deleterious effects of background TV when testing was delayed than when testing occurred immediately.

Methods

Subjects were 95 undergraduates from lower-level courses in introductory communication theory and small group communication, who volunteered their time in exchange for small amounts of extra course credit. Subjects were randomly assigned to one of three television or control conditions, and to one of two alternative test orders. Subjects read and studied a newspaper science feature article, and later took a short answer recall test on its content. Subjects in the treatment conditions did the reading and test while a TV drama program or a series of television advertisements was played in the background; control subjects worked in quiet. The reading test was taken either immediately following the reading, or after a delay of about five minutes and the completion of an intervening nonverbal task (the Tower of Hanoi puzzle).

Experimental manipulations

Treatment subjects received one of two extremes of naturally occurring television content. Those in the TV Drama condition were exposed to a videotaped episode of one of two prime-time "soaps": either Dynasty or Knots Landing. These had been selected earlier to be low in physical action and perceptual salience, high in verbal content (that is, a high proportion of program time was spent with some character talking), and

having a coherent story line. The programs were edited to remove commercials. Subjects in the TV Ads condition were exposed to one of two videotapes containing a series of broadcast ads. One set of ads had originally appeared in prime time; the other during TV sports broadcasts. The ads contrasted with the drama program content in that they were high in perceptually salient features (cuts, special effects, etc.), and did not form a coherent story over the course of the experimental session.[10]

Dependent measure

Reading tests were constructed for a series of newspaper science features and pretested under group conditions. Based on these pretests, two articles and tests were selected that required a reading time of about 10 minutes and which could be scored reliably. The articles selected were a feature on "Marfan's syndrome" and one on exotic methods for dealing with atmospheric pollution.[11]

Control variables

Since students differ widely in reading and study abilities, it was important (in a between-subjects design) to control for prior variation in such abilities. Three sources of information were used.

First, all participants filled out a pretest questionnaire in which they reported a broad range of information on their background and prior academic performance: Year and major in school; overall grade point average; number of courses taken in communication, literature, social science, natural science, and mathematics; and grade point in courses taken in each of these areas.

In addition, information about subjects' high school performance, and scores on college placement tests were obtained from the University registrar (with written permission of participants).

Finally, before beginning the experiment proper, each participant took a 3-minute paper-and-pencil true/false "sentence verification" test. This test measured how rapidly the subject could process sentences such as "A is not preceded by B," comparing its meaning to a picture in which letters were in some such relation. Speed of performance on this sort of test correlates reliably (at a moderate and significant degree) with performance on longer conventional reading comprehension tests (Baddeley, 1968; Lansman, 1978). All subjects took this test in quiet.

As might be expected, many of the prior achievement measures were strongly intercorrelated. Therefore, prior to further analysis, a principal components factor analysis was conducted on the 15 achievement measures for the purpose of data reduction. Four factors with eigenvalues greater than 1.0 were obtained, accounting for 62% of the variance in the set. Factor scores were computed for each case on each of the four varimax rotated orthogonal factors, using factor score coefficients.

A number of additional control variables were also measured on the pretest background questionnaire. Subjects were asked to report their level of knowledge about Marfan's Syndrome, and about "the Greenhouse Effect and its causes," on a scale from 0 (never heard of it) to 8 (know a lot about it). Newspaper exposure, level of fatigue at the beginning of the experiment, and socioeconomic status (family income, mother's and father's levels of schooling, and mother's and father's occupations) were also assessed on the background questionnaire.[12]

On a posttest questionnaire, subjects were asked how well they had expected to do on the tests after having heard the instructions (which told treatment subjects that they would have to work in the presence of an operating TV). Participants also estimated their degree of motivation and the amount of effort they had put into the test-taking (both on 0 to 10 scales). The latter two (highly-correlated) measures were combined to form a single "effort" score. Other posttest questions asked about habitual television viewing, how often the subjects studied or read in the presence of an operating TV,[13] and how quiet or noisy was the place in which they did most of their reading or studying.

Procedure

Participants were tested individually in a lab equipped with a comfortable couch, a table at about knee height, and a television and VCR, which was placed at about a 45% angle to the left of the subject. A research assistant conducting the session sat at about a 45% angle to the right of the subject, and across the table.[14] Subjects were randomly assigned to control, TV-drama, and TV-advertisement conditions and to immediate or delayed testing of retention of reading material.

Subjects were greeted, directed to the couch, and given a consent form to fill out. After completing the consent form, subjects were presented with page entitled "general instructions." They were asked to read along while listening to a tape-recorded version of the instructions, which contained two items designed to increase motivation. First, the instructions stated that the number of points of extra credit a student could earn from the study would depend on how well he or she performed on the tests.[15] Second, subjects were told that performance on the type of

tests they would be given, while under conditions of competitive stress or distraction, was a good predictor of future professional performance (cf., Quattrone & Tversky, 1984).

After completing a background questionnaire containing items measuring prior academic performance, SES, and level of fatigue, the participant received a second set of instructions, labeled "Test Instructions." In the TV-condition only, this instruction sheet contained a final paragraph which read as follows:

> Part of what we are testing is your ability to overcome distracting conditions while demonstrating the skills that are being measured. For this reason, beginning with the second test, there will be a television operating in the room with you while you are working on these tests. DO YOUR BEST TO IGNORE THE TELEVISION AND CONCENTRATE COMPLETELY ON THE TESTS. YOU ARE BEING EVALUATED SOLELY ON YOUR TEST PERFORMANCE.

All subjects then were administered the three-minute "sentence verification" test in quiet. Afterward, the videotape was started in the television conditions. Subjects then completed a 3-minute buffer task (a set of figural analogies) to allow TV-condition subjects to become acclimated to operating with the television on.

Following the buffer task, subjects were given one of the two science readings, along with written instructions telling them to study it as if for a short answer (not multiple choice) test for a class, and to underline the article or mark it as they wished. They were given 10 minutes to read and study the article, after which the reading was returned.

At this point, approximately half of the subjects were given a short-answer test measuring their learning from the science article they had just read. The other subjects were assigned to do an intervening nonverbal test taking about 4.5 minutes (5 to 5.5 minutes including setup), before completing the test on the content of the science article.

At the completion of the tests, the television was turned off, and subjects were given the posttest questionnaire. Finally, each participant read a written debriefing form, and was asked to keep information about their experiences confidential until the end of the semester. No significant leakage of study details occurred (as reported by subjects on the posttest questionnaire).

Analysis

Analysis of television effects on reading test performance proceeded in three stages. First, a multiple regression analysis was performed. Reading test performance was predicted by the set of prior achievement measures and other background variables described earlier (SES, media use measures, prior knowledge of the topic of the article, motivation and effort, fatigue immediately prior to test taking, and level of success expected at the beginning of the test-taking), a dummy variable representing immediate versus delayed testing, and a dummy variable representing the contrast between television and control conditions.

A stepwise procedure using backward elimination allowed assessment of effects with all control variables in the model, and progressive extraction of an optimal subset of significant predictors.[16] The regression analysis resulted in a test of the effect of television vs control conditions in

general, and produced a set of significant control measures for use as covariates in the latter stages of analysis.[17]

We next conducted a 1 X 3 Analysis of Covariance, with 3 levels of treatment (control, TV-drama, and TV-advertising), yielding planned contrasts between control and each television content type separately, controlling for the influence of the set of significant covariates obtained from the earlier regression analysis (Achievement Factor 1;[18] self-reported effort; self-reported prior fatigue; and prior information about the article topic). Finally, a 2 X 3 (treatment condition by immediate vs delayed testing) ANCOVA was conducted, with the same set of covariates. The purpose of this analysis was to test the prediction of stronger TV distraction effects occurring under delayed testing.[19]

Results

Table 1 reports the results from the stepwise regression analysis with backward elimination. As predicted, the contrast between TV and Control groups is significant, with subjects in the control condition scoring higher on the reading test.[20] As noted earlier, four control variables also made significant contributions: Self-reported effort, prior information on the reading topic; prior fatigue; and Achievement Factor 1.

Results of the 1 x 3 ANCOVA (control vs TV-drama vs TV-advertisements) are reported in Table 2. Again, the overall effect of treatment condition was significant, with the highest mean test score (adjusted for the influence of covariates) occurring in the control (quiet) condition. The t-value associated with the planned contrast between

control and TV-ads was significant at the .05 level, but the control/TV-drama contrast only achieved a borderline .07 probability.

Table 3 reports findings from the 2 x 3 (treatment x immediate/delayed testing) ANCOVA. The main effect of treatment condition remained significant, controlling for covariates, immediate/delayed testing, and the treatment x immediate/delayed testing interaction. There was, however an interaction of borderline significance ($p = .09$). Examination of the cell means reveals that this was the result of a seemingly anomalous improvement in the performance of TV-drama condition subjects under conditions of delayed testing.

Discussion

Armstrong and Greenberg (1990) found that background television impaired cognitive processing on several types of difficult and complex intellectual tasks, but had no measurable effect on simple, self-contained, and relatively easier tasks. However, a deleterious effect of TV on reading comprehension was only found when subjects were motivated through instructions to attend at least minimally to background TV content. Armstrong and Greenberg interpreted this set of results in terms of competition between background television and the primary information processing tasks for a limited pool of central processing resources ("capacity interference"). From this perspective, interference should not result in deterioration of performance until the total resources required by a set of concurrent activities (TV and the primary task) exceeds available processing capacity.

An explanation in terms of capacity interference implied that if a reading task was made more difficult, performance decrements should occur even when readers were motivated to tune out or ignore the television entirely. In order to test this, subjects were given a reading passage that was longer and more difficult than those used in the Armstrong and Greenberg study, and memory was assessed by a recall test rather than a multiple-choice recognition test.

TV content was also varied in order to examine the possibility that some TV formats may be inherently more distracting than others and thus more likely to compete for information processing resources. In the Armstrong and Greenberg study subjects were exposed to two types of TV drama programs while performing tasks. In the present study, effects of TV drama were compared to the effects of a long sequence of commercials. Commercials typically involve a greater concentration of the type of perceptually salient or informative formal features that induce involuntary attentional shifts (including orienting responses). It was therefore hypothesized that the background commercials would provide stronger competition for processing resources than other television formats, at least under conditions in which subjects were attempting to ignore the television rather than monitor its content. In this case, exposure to TV ads should have caused the most deleterious effect on reading comprehension and memory.

A significant main effect of background television was obtained, as predicted. Control condition subjects did better than subjects in the television conditions, controlling for prior achievement, the subject's self-reported effort, prior information, and fatigue. Other variables that

could have led spuriously to this result (such as expectations about performance resulting from test instructions) were analyzed and failed to account for the findings.

This result supports the notion of capacity interference put forward earlier by Armstrong and Greenberg (1990). By creating a more difficult study task, and measuring recall rather than recognition, deleterious effects of simultaneous viewing on reading task performance were obtained even when subjects were directed not to attend to television content.

Beyond this basic finding, however, several expectations were not supported. It was predicted that the effects of background TV would be stronger when testing was delayed rather than immediate. In fact, the most consistent differences between control and television conditions were found when testing took place immediately following the reading, rather than after a five-minute delay.

However, it is possible that when testing was delayed the difference between control and television conditions was obscured by floor effects. The use of a reading task difficult enough to provide strong competition for processing resources even under conditions of immediate testing, meant that all scores in the delayed condition were low. Moreover, the delay period was filled with a difficult intervening task (The Tower of Hanoi) which may have interfered with consolidation of memory traces from the reading and contributed to the low scores. Means were extremely low (given a possible top score of 33), and it seemed that a non-trivial number of subjects recalled little or nothing from the reading passage, answering questions based on guessing and on prior knowledge.

It is also possible that even without floor effects, the delay of five minutes would have been insufficient to reflect differences between control and television groups in ability to organize and store information in long term memory. Since the effects of background television on long term memory are pertinent to the debate over effects of television on academic performance, the authors are developing a further study which will incorporate testing of recall memory after a 24 hour delay.

It was also hypothesized that subjects exposed to background commercials would do worse than those exposed to drama, but this was true only when testing was delayed. With immediate testing, the performance of the two groups was similar, with a slightly lower sample mean in the drama condition.

The most curious result had to do with the relatively strong performance under delayed testing conditions by the TV-drama condition subjects, which produced an interaction effect of borderline probability. We are cautious about interpreting this finding, given the lack of statistical significance. There may simply have been a failure of randomization.[21]

Alternatively, if this result is real, it suggests the intriguing possibility that delayed recall was assisted by context cues from connected drama. In this study, subjects in the television condition had the television on both while studying the passage and while taking the test. There is some research evidence that retrieval of information is facilitated when the context at time of retrieval is the same as the context at time of encoding (see Hess, 1984; Hess & Higgins, 1983; Hutchinson, 1989; Simon, 1979). Jacoby and Craik (1979) argue that this is

because the memory of an event's initial occurrence incorporates information about both the event itself and its context. If the event is then presented in the same context on the second occasion, there will be a greater degree of overlap between trace information and test stimulus information; and the probability of recall will be increased (cf. Tulving and Thomson 1973).[22] Within the television drama programs used in the experiment, the same characters, voices, and music kept reoccurring. It is possible that the presence of these at both encoding and retrieval facilitated recall, thus leading to a marginally better performance for those in the drama condition than for those in the commercial condition where the voices and characters kept changing. This account is, of course, presently just speculation, but the authors are currently working on a study to examine this possibility systematically.

In conclusion, the aim of this study was to examine the effects of background television on ability to perform difficult reading comprehension and memory tasks. The theory was that television would compete for central processing resources and thus interfere with ability to process and store the information being read. While the predicted main effect for background television was found, the study raised a number of issues that need to be addressed in further research: How television exposure interacts with delay between time of encoding and time of retrieval; can television provide context cues at encoding and thus facilitate information retrieval if present at time of testing?

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Table 1. Regression predicting adjusted reading comprehension score: All predictors.

Predictor	Beta	Significance
EFFORT	.228	.0122
ACHIEVEMENT FACTOR 1	.254	.0052
CONDITION (TV vs CONTROL)	-.233	.0107
PRIOR INFORMATION	.382	.0000
PRIOR FATIGUE	-.203	.0290

R Square = .340

F = 9.17572

Signif F = .0000

N = 95

Table 2: Adjusted reading score by program condition in 1 X 3 Analysis of Covariance.

Condition	Adjusted Mean
Control	9.19
TV-Drama	8.00
TV-Ads	7.58

Overall Tests of Significance:

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	520.32	85	6.12		
REGRESSION	245.51	4	61.38	10.03	.000
CONSTANT	20.40	1	20.40	3.33	.071
CONDITION	41.42	2	20.71	3.38	.039

Significance of planned contrasts.

Contrast	t-value	significance
Control vs. TV-Drama	-1.854	.07
Control vs. TV-Ads	-2.50	.02

Table 3. Adjusted reading score by program condition and time of test in 2 X 3 analysis of covariance.

Overall Tests of Significance

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	520.32	85	6.12		
REGRESSION	245.51	4	61.38	10.03	.000
CONSTANT	21.16	1	21.16	3.46	.066
TV BACKGROUND	40.80	2	20.40	3.33	.040
TIME OF TESTING	.23	1	.23	.04	.847
TV BACKGROUND BY TIME	29.98	2	14.99	2.45	.092

Adjusted cell means by program condition and time of test.

Program Condition	Time of Test	
	Immediate	Delayed
Control	9.85	8.55
TV-Drama	7.41	8.85
TV-Ads	7.79	7.35

Footnotes

1. The authors would like to recognize the contributions of our undergraduate assistants to various stages of this project. Without the valuable volunteer help of Janice Esser, Rick Baron, Yick-Kau Miu, and Jennifer Guay, it would have been much more difficult to complete this research.

2. Television can influence arousal levels as a result either of content characteristics (Zillman, 1982) or of the cognitive demands of a "dual-task" viewing situation (effort-induced arousal). When secondary viewing results in increased arousal (which should occur more often than the opposite), the effect on concurrent processing could be either positive or negative, depending on the prior physiological state of the individual, and the type of cognitive task in which he or she is primarily engaged. Overall, arousal and cognitive performance are related curvilinearly, with best performance at some middle level. High arousal has more deleterious effects for more complex and difficult intellectual operations (Anderson & Revelle, 1982; Boggs & Simon, 1968; Yerkes & Dodson, 1908).

3. The three tasks that were negatively affected by background television in the Armstrong and Greenberg (1990) experiment were: (1) a test of creativity/ideational fluency involving the generation of different possible uses for a common object; (2) a shortened version of the passage comprehension Nelson-Denny Reading Test, a standardized reading achievement measure used most commonly with high school juniors and seniors; and (3) the Tower of Hanoi puzzle, a difficult spatial task involving means-ends analysis. The tasks for which significant effects of background television

were not found were: (1) a digit span test of (passive) short-term memory; (2) a "mental arithmetic" test of working memory capacity; (3) a "sentence verification" test of syntactic processing speed and accuracy; and (4) a letter-series completion test.

4. From this standpoint, the reading test used by Armstrong and Greenberg may have left enough spare capacity to effectively tune out the unwanted perceptual input from the TV without impairing performance, but not enough additional capacity to pay minimal attention to the TV without ill effect.

5. For this reason, deleterious effects of background television on storage and retrieval of written information could result not only in lower levels of reading achievement, but also in worse general academic performance.

6. In Kintsch & van Dijk's model, other aspects of reading also require processing resources. The more difficult the text (i.e., the more resources that must be allocated to syntactic-semantic analysis, inference generation, and like as a result of text unfamiliarity, complexity, or unusual semantic structure), the fewer the resources available to other aspects of processing. However, Kintsch and van Dijk argue that in much everyday reading, the ongoing sense-making process (involving local coherence) is largely automatized, and thus has relatively low processing resource requirements.

7. Later recall of information from text depends upon initial comprehension, effective memory storage, and an active process of retrieval and reconstruction. Both storage and retrieval/reconstruction processes can require significant processing resources, and an inability to recall

information at a later time can result from failure at either point (Parkin, 1987).

8. The television programs to which the Armstrong & Greenberg subjects were exposed had the commercials excised through editing.

9. Moreover, it is likely that when heavy viewers are reading or studying in front of the television, they will prefer to focus on their work more during commercial breaks than during the programs themselves. Thus, commercials should constitute the background to study activities relatively more often than other types of content.

10. Two programs were selected to act as manipulations of each type of program content, rather than a single instance of each type, in order to reduce the chances that variation between TV stimuli on dimensions that were not of theoretical interest could confound interpretation of findings (cf., Bradac, 1983; Jackson & Jacobs, 1983) Which specific program or set of commercials each subject received was determined through random assignment.

11. In scoring the reading tests, inter-coder correlations were above .95, and only rarely did scorers differ by more than a half-point out of a possible 33.

12. For newspaper exposure, subjects were asked to report the number of days in the previous week in which they read each of 10 newspapers. These scores were combined into two measures reflecting reading of 2 campus newspapers and 8 non-student newspapers respectively. Participants were asked to estimate amount of fatigue they were experiencing, on a 0 to 10 scale ranging from "after a good nights sleep" to "after staying up all night."

13. Subjects were asked to estimate the number of hours they viewed in four time periods on a typical weekday., and the number of days the previous week in which they watched more than one hour of TV in each of four time periods. From these, two additive measures of TV viewing were constructed: an "hours per day" measure, and a "days per week" measure. Two questions asked about how often the subject would read or study for class while listening to a TV, and how often the subject read for his or her own pleasure under these conditions (on 0 to 10 scales from "never with TV" to "always with TV").

14. During the reading assignment and test, the person administering the session was instructed to read a book or magazine and to avoid staring at the subject or watching the TV. Due to the number of questionnaires, buffer tasks, and so on that had to be administered, and the need for accurately timing the readings and tests, it was impractical for the experimenter to leave the room during testing.

15. In actuality, all participants received the same, larger, amount of extra credit.

16. Since the intent was not to interpret the effect of control variables on reading scores, use of a stepwise procedure does not capitalize on chance in a manner that threatens validity. The stepwise procedure was intended in part to produce a reliable, significant set of control variables for use in later analyses.

17. To remain in the regression equation, control variables had to achieve a .10 probability. From the standpoint of interpreting treatment effects, this is actually a conservative procedure, in that no individual

variable that could conceivably account for treatment effects is eliminated.

18. The background variables with primary loadings on this factor were primarily the set of self-reported grade point averages (overall GPA, plus GPA's in communication, social science, natural science, mathematics, and literature courses at the University).

19. The 1 X 3 ANCOVA had 31-32 subjects per cell, with these figures halved on the 2 X 3 analysis.

20. The effect of Control-vs-TV condition was also significant at the .05 level in the regression analysis containing all possible control variables.

21. The analysis of immediate versus delayed effects involved cell sizes averaging only 16 cases. In addition, of all cells in the analysis, the TV-drama/delayed testing cell had the fewest cases: A result of the necessity to eliminate several subjects because of outside noise or interruptions during testing.

22. Interestingly, there is some evidence that context effects may occur for recall tests, but not for recognition tests (Godden & Baddeley, 1980).